

Results of Projects on Collecting, Mapping, Monitoring, and Conserving of Plant Genetic Resources 1990–2008

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Abstract: Old landraces and obsolete cultivars represent a national heritage that must be conserved for future generations. Similarly, crop wild relatives (CWR) are a valuable gene pool for plant breeding or for direct introduction as a new crop. These materials have been mapped, collected, evaluated, regenerated, and conserved in the Gene Bank. In total, 3726 seed and vegetative samples have been collected in the Czech Republic, as well as 1582 abroad (in Slovakia, Poland and Austria) during cross-border cooperation projects. All collecting sites (over 1000) were located by GPS and plotted using the Geobáze Professional 2.8 mapping software. Altogether, 688 samples were declared as a national collection, and 627 seed accessions were conserved in the Gene Bank. In addition, 842 accessions of fruits were recommended for *in situ* conservation. Selected species of the families *Poaceae*, *Fabaceae*, and *Alliaceae*, which are rare or threatened in the Czech Republic, have been monitored *in situ* for 3–5 years. Two sites were suggested for protection as new protected areas.

Keywords: collecting; conservation; crop wild relatives; landraces; mapping; monitoring; plant genetic resources

The preservation of biodiversity and natural variation within species has become a global concern. Natural variation is essential to the evolutionary process and the long-term survival of species. Genetic diversity ensures that no two members of a species or population are genetically identical, and that no individual carries all of the possible trait variants in that particular species. This diversity within a species allows it to survive and adapt to new environments, new pests, and changing climates (RIEBER 1998). The rate at which our planet's environment is currently changing is increasing dramatically, due to human activities around the world. Therefore, the relevance

of the genetic diversity of plants (and other life forms) to adapt to these changing conditions is now greater than ever. Furthermore, as humans, we also face the uncertainty of our actions in the future. In an environmentally dynamic world, with constantly increasing population and limited resources, we need to conserve genetic diversity for our own foods as well as for environmental security (IRIONDO *et al.* 2008).

Wild species, which are related to or ancestral forms of cultivated crops (crop wild relatives, CWR), are a valuable gene pool for plant breeding, or for direct introduction as a new crop (GUARINO *et al.* 1995). Old landraces and obso-

lete cultivars represent a national heritage that must be conserved for future generations. Important attempts to gather landraces in the Central European territories were made in the 70's–80's with German-Czechoslovakian collections, led by Kühn, Tempír, Hammer, Hanelt, Pistrick, and others (KÜHN *et al.* 1982) in 1974–1989; and by German-Polish collections led by Kulpa, Górski, Jastrzębski, Hammer, Hanelt, and others (HAMMER *et al.* 1981). Among the CWR, most species are common; however, there are many species which are of limited occurrence, are endangered, or are critically endangered (PROCHÁZKA 2001; SLAVÍK 1988–2004).

In the early 1990s, an inventory of wild and historical genetic resources in germplasm collections was initiated (HOLUBEC 1999; HOLUBEC *et al.* 2003). A small amount of such materials were found in the Czech collections. New projects for collecting extant fragments of CWR and landraces have been started.

Objectives

The objectives of a series of projects from 1990 to 2008 therefore were as follows:

- To find extant fragments of traditional landraces in the Czech Republic, as well as within the neighbouring Central European countries.
- To gather these into the gene banks by means of collecting and repatriation.
- To collect crop wild relatives for *ex situ* collection.
- To map useful biodiversity.
- To monitor the threatened biodiversity of plant genetic resources (PGR).
- To promote *in situ* and on-farm conservation.

MATERIALS AND METHODS

Landraces and obsolete cultivars were priority materials, but their access was very limited, due to severe genetic erosion. Remote settlements, occupied by older people, increased the likelihood of finding crops from self-propagated seeds. The seeds were requested from farmers or collected in the field. In the case of donated samples, larger quantities were requested to cover population diversity. Fruit landraces were investigated within

old plantations, abandoned settlements, orchards, avenues, and scattered trees in the rural landscape. Fruits were determined as to cultivars; trees were located by GPS and mapped for the later collecting of grafting materials.

Wild plants (CWR), useful for man and agriculture, were preferably collected from primary sites that were not subjected to intensive agriculture. Among the wild plants, the following groups were targeted during collecting: grasses, fodder legumes, aromatic, medicinal, and meadow dicotyledons. The field collections were if possible directed toward the botanically rich regions, but also to cover various climatic and geographic regions of the country. The principal method was the gathering of bulk samples from many plants (at least 30, if possible). All sites were located using GPS, and then later mapped using GIS or Geobáze Professional 2.8 mapping software. Ecological conditions were noted, together with geographical data, and then recorded into the collection database.

At national border regions, the collecting was done on both sides, with the cooperation of the neighbouring country's gene banks. Joint projects involving cross-border cooperation were designed with gene banks in Slovakia, Poland, and Slovenia; and an additional informal cooperation agreement was set up with Austria to enable both collecting and material exchange (Table 1).

RESULTS AND DISCUSSION

Collecting activity

Collecting missions started in 1990, when the cooperating institute, RIPP (Piešťany, Slovakia), organized a trip in the footsteps of Karl Hammer's expeditions in the seventies. The trip was aimed at collecting landraces within the Czech – Slovak border region, in both the White and Small Carpathians. This region consists of undulating countryside, with a great many small settlements which still retain the names of the original families. The region is typified by small fields with a wide range of crops – a unique treasury of still existing landraces. It was as if time had stopped there in the last century. Most of the collected samples were wheat, barley, and rye. Three samples of emmer wheat (*Triticum dicoccon* Schrank) were found. A great variability of the poppy landraces was seen, especially with long purple capsules.

Table 1. Countries participating in joint expeditions

Year	Expedition region	Participant countries
1990	Biele/Malé Karpaty Mts	SVK, CZE
1993	Bílé Karpaty Mts	CZE
1994	Šumava Mts/Böhmerwald	CZE, AUT
1995	Krkonoše/Karkonosze Mts	CZE, POL
1996	Orlické hory Mts	CZE, POL
1997	Podyjí/Thayatal	CZE, AUT
1998	Krušné hory Mts	POL, SVN
1999	Beskydy/Beskid Mts	CZE, SVK, POL
2000	Jeseníky/Roháče Mts	CZE, SVK, POL, SVN
2001	Moravian Karst/Lower Tatra	CZE, SVK, SVN, POL
2003	Pálava	CZE, SVK
2004	České středohoří/Muráňská Planina	CZE, SVK
2005	Křivoklát/Pieniny Mts	CZE, SVK
2006	Novohradské hory Mts/Waldviertel	CZE, AUT, SVK
2007	Moravian Pannonia	CZE, SVK
2008	Českomoravská vrchovina Mts	CZE, SVK, SVN

CZE – Czech Republic, SVK – Slovakia, SVN – Slovenia, POL – Poland, AUT – Austria

The grass pea (*Lathyrus sativus* L.), an old legume originally used for soups and pastes, should get special attention.

In fact, the systematic collecting started in 1993, when the first grant was received. The collecting commenced on the Moravian side of the White Carpathians within the territory of the Bílé Karpaty Protected Landscape Area (PLA); this group was guided by conscientious botanists. During the mission, mainly wild species were collected, especially grasses and fodder legumes (Table 2). Among them, one species of a critically endangered Czech Republic plant, *Pedicularis exaltata* Bess, was collected for *ex situ* conservation in the Gene Bank.

The subsequently missions were organized with the cooperation of gene banks in Poland (Krkonoše and Orlické hory Mts), or in Austria (Šumava/Böhmerwald, Podyjí/Thayatal, and Novohradské hory Mts/Waldviertel, in the Viehberg region). During the missions to the national parks (NP), the programme was prepared together with either NP or PLA-responsible botanists. Those responsible prepared maps showing the distribution of fruit trees, which our pomologists had determined, and made notes of the field evaluations. They also

marked and noted valuable material for future grafting and possible *in situ* conservation. These data were summarized into a database, which was also provided to the national parks for *in situ* set up and management. Šumava NP yielded a great number of sweet cherry accessions from altitudes of around 1000 m, with a good health status. On the Austrian side, a cider manufacturing region was visited. Among herbs collected, there were also several endangered species that were collected with the permission of NP/PLA, and that have since been stored in the Prague Gene Bank as a special *ex situ* collection. A similar species range within the *Poaceae* and *Fabaceae* families has been collected in the Šumava and Novohradské hory Mts.

The collecting in the Krušné hory Mts was mainly devoted to herbaceous materials. It was undertaken regularly, on a network basis, on a large territory in the most polluted region of the Czech Republic. Most of the samples were grasses and fodder legumes.

The collecting mission to the Beskydy Mts was directed toward the whole phytogeographic region of this large mountain range in the Czech Republic, Poland, and Slovakia. All three gene banks and

Table 2. Collection of seed samples during expeditions within the territory of the Czech Republic

Year	Expedition acronym	No. of localities	No. of accessions	Land races	Grasses	Fodder legumes	Vegetables aromatic medicinal	Meadow dicots	Fruits	Other
1993	CZKKARP	15	250	6	53	54	0	85	8	44
1994	CZKSUM	55	487	7	238	142	51	47	53	4
1995	CZKKRK	74	378	1	202	56	47	11	38	23
1996	CZKORL	36	269	2	131	69	0	53	8	6
1997	CZKDYJE	27	228	0	106	64	0	48	10	0
1998	CZKKRUH	33	376	0	126	115	92	37	1	5
1999	CZKBES	27	344	7	101	53	43	35	105	35
2000	CZEJES	27	284	0	158	61	41	22	0	2
2001	CZEMKRAS	12	181	0	57	40	10	28	1	45
2003	CZKPAL	21	239	0	93	42	76	22	2	4
2004	CZKCESTR	18	156	0	32	48	56	8	0	12
2005	CZKKRIV	19	151	0	49	35	54	0	1	12
2006	CZKNHR	26	83	1	38	25	13	0	0	6
2007	CZEPAN	16	163	3	33	62	45	10	1	9
2008	CZEVARCH	17	137	0	46	42	43	3	0	3
Total		423	3726	28	1463	906	473	445	228	216

PLA-responsible botanists participated in preparing such a large programme. Overall, the mission yielded the largest amount of samples collected (650). The most valuable landraces were collected

in Poland: black pea (*Pisum sativum* L. convar. *medulare* (Alef.) C.O.Lehm.) with a dark brown colour of the grains, vegetable faba beans (*Faba vulgaris* Moench.), and common beans (*Phaseolus*

Table 3. Summary of joint and cross-border collecting activities

Country	Year	Region visited	No. of localities	No. of accessions	Land races	Wild species
Slovakia	1990	Biele/Malé Karpaty Mts	17	103	73	30
	1999	Beskydy Mts	22	283	88	195
	2000	Roháče Mts	24	248	42	206
	2001	Lower Tatra Mts	20	338	29	309
	2004	Muráňska Planina	14	105	0	105
	2005	Pieniny	15	111	18	93
Poland	1995	Krkonosze Mts	7	22	0	22
	1999	Beskid Mts	17	183	8	175
Austria	1994	Böhmerwald	16	132	22	110
	1997	Thayatal	7	52	0	52
	2006	Waldviertel	3	5	0	5
Total			162	1582	280	1302

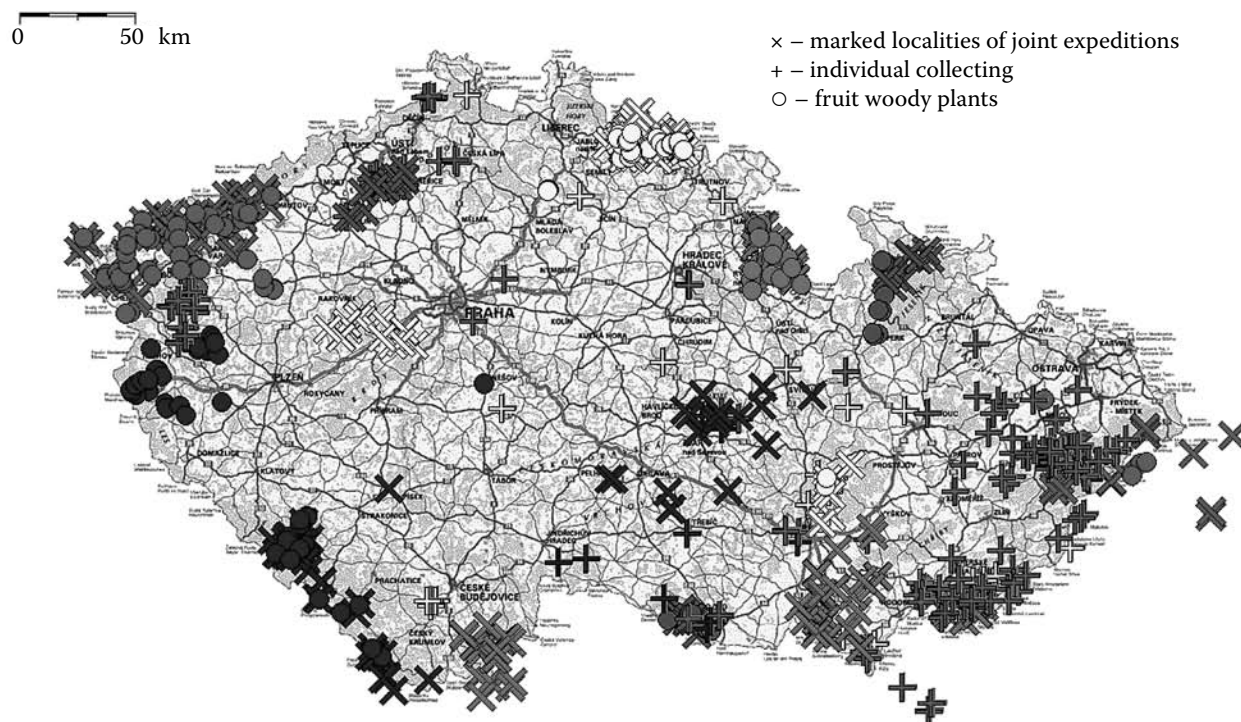


Figure 1. Collecting sites of crop wild relatives and landraces within the Czech Republic and the bordering zones with Poland, Slovakia, and Austria (Geobáze, Map of the Czech Republic 1:100 000)

vulgaris L.). During the mission to the Jeseníky Mts, two threatened CWR were collected with the permission of PLA Jeseníky: *Poa riphaea* (A. et Gr.) Fritsch and *Allium schoenoprasum* L. subsp. *alpinum* (DC.) Čelak. The former is the most restricted endemic plant of the Czech Republic; the latter is restricted to only two localities. Both were successfully regenerated in germplasm collections, evaluated, and then put into the Gene Bank.

The missions to the Moravian Karst, Pannonia, Pálava, Podyjí, and České středohoří were devoted to wild plants; mainly to thermophytic flora on limestone or basalt. A large diversity of aromatic, medicinal plants, and meadow dicotyledons was gathered; and thus the germplasm collections have been enriched with these new species. Monitoring of selected threatened *Fabaceae* and *Poaceae* species has been set up.

The last mission to the Českomoravská vrchovina Mts yielded about an equal share of grasses, fodder legumes, and aromatic/medicinal plants. Two forms of horseradish and wild garlic species were collected, and enriched the vegetable collections.

In total, 3726 seed and vegetative samples were collected in the Czech Republic (Table 2), as well as 1582 abroad (Table 3). From the samples collected

abroad (70%), most (22%) came from Slovakia, with fewer coming from Poland and Austria (4 and 3.5%, respectively). While landrace collecting was very low in the Czech Republic (only 28), ten times more have been collected abroad (280), with the highest share in Slovakia. This is associated with the abolition of private farmers after the Second World War in the Czech lands.

Site mapping

All collecting sites (over 1000) have been located by GPS and plotted on the Geobáze Map (Figure 1). In the case of the herb localities, the coordinates were taken roughly in the middle of the locality. In the case of fruit trees, particular trees were located as precisely as the Garmin system allowed. It is possible to assume that the territory of the Czech Republic has been thoroughly covered by collecting activities. In particular, the mountainous regions, as well as those with a certain level of protection, have been covered. Remote areas were expected to provide original wild materials and fragments of landraces. In fact, it is very regional. Landraces were more available where fruit trees had not

Table 4. Collected samples which received a National Accession Number within the EVIGEZ national documentation system, and those conserved in the Gene Bank (data from EVIGEZ; I. FABEROVÁ)

Collections Country	Documented in EVIGEZ				Conserved in the Gene Bank		
	total	regular	protected	working	total	regular	protected
CSK, CZE	511	441	51	19	470	425	45
SVK	98	85	9	4	90	83	7
AUT	31	29	1	1	30	28	2
POL	2	2	0	0	2	2	0
Total	688	600	65	23	627	570	57

CSK – Czechoslovakia, CZE – Czech republic, SVK – Slovakia, AUT – Austria, POL – Poland

been cut down (e.g. the Šumava border zone or the Doupovské hory Mts) were rich, because they were and the latter still is closed military areas. On the other hand, another promising region, Orlické Záhoří (a strip between mountains and the Polish border) was poor, because there has been intensive agriculture for the last 40 years. For the herbaceous flora, the secondary habitats were usually the richest, but they were not a target for our collecting. Most original and unique grasslands were in protected areas (such as the Rybí meadow in Šumava NP). The target areas for collecting were mainly pastures and meadows that had not been ploughed for many years. The richest diversity was found in the Bílé Karpaty and Podyjí regions.

Cross-border collecting has been thoroughly done along most of the Czech-Slovak border. The Austrian border regions were covered within all three mountain groups or protected regions (Böhmerwald, Waldviertel, and Thayatal). On the Polish side of the border, the only areas visited were in the Karkonosze and Beskid regions (Beskid Orawski, Babia Gora, Beskid Żywiecki, and Beskid Mały). There is still quite a substantial length of border area remaining to be covered.

Documentation and conservation

All collected samples were recorded into the collection database, where samples are given collection and locality numbers, as well as passport data on the locality; items noted included geography, ecology, and vegetation.

When it was decided to add a sample to the national collection, it received a National Accession

Number, and all passport data are recorded into the EVIGEZ national information system. Many collected samples failed in competition: a certain number did not germinate or had a critically low number of seeds. Most of the excluded samples appeared to be unsuccessful in the evaluation process during regeneration. The results on inclusions of the materials into the national collection are given in Table 4. From the total of 3726 samples collected, only 688 were proclaimed worthy of the national collection and received a National Accession Number. Altogether, 627 seed accessions were conserved in the Gene Bank. Over 74% came from collecting in the Czech Republic, 14% came from Slovakia, and 4.5% came from Austria.

In addition, 842 accessions of fruits were recommended for *in situ* conservation that is not recorded in EVIGEZ.

Sample regeneration

Collected samples were treated according to the amount of seeds available. Samples with a sufficient quantity were cleaned, dried, and provided for conservation to the Gene Bank directly. Other non-standard samples were included for a working collection, in specialized collection holders. They were regenerated, evaluated, and then provided for long-term storage.

Monitoring

Selected species of the families *Poaceae*, *Fabaceae*, and *Alliaceae*, which are rare or threatened in the Czech Republic, have been monitored *in situ*

for 3 to 5 years. The aim was to evaluate threats and site stability, as well as to discover possible stressors. Most of the 50 sites were stable, without obvious changes. One site was excluded because the target species had been destroyed by human activities (Jílovský brook). One site was heavily damaged due to repeated floods and embankment construction (Zbraslav). This site was re-seeded naturally from the soil's own seed bank. Two sites were suggested for protection as new national reserves. For selected sites, a suitable management plan was recommended in order to maintain the present status.

CONCLUSIONS

By adopting the programmes on collecting, mapping, and monitoring of crop wild relatives and landraces, the spectrum of Gene Bank activities has moved to a new level. The share of those materials in the national collections has been significantly increased. Material of CWR from the territory of the Czech Republic and bordering zones of Slovakia, Poland, and Austria, is now available for research and breeding, as well as being conserved in perpetuity. It was possible to disclose threats to selected wild plants either currently or potentially useful for agriculture. It was possible to start *in situ* and on-farm projects as new methods for conservation of agro-biodiversity.

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